Instrument Incubator

CARBO: The Carbon Balance Observatory

Completed Technology Project (2017 - 2019)

Project Introduction

Scientific consensus from a 2015 pre-Decadal Survey workshop highlighted the essential need for a wide-swath (mapping) low earth orbit (LEO) instrument delivering carbon dioxide (CO2), methane (CH4), and carbon monoxide (CO) measurements with global coverage. OCO-2 pioneered space-based CO2 remote sensing, but lacks the CH4, CO and mapping capabilities required for an improved understanding of the global carbon cycle. The Carbon Balance Observatory (CARBO) advances key technologies to enable high-performance, cost-effective solutions for a space-based carbon-climate observing system. CARBO is a compact, modular, 15-30° field of view spectrometer that delivers high-precision CO2, CH4, CO and solar induced chlorophyll fluorescence (SIF) data with weekly global coverage from LEO. CARBO employs innovative immersion grating technologies to achieve diffraction-limited performance with OCO-like spatial (2x2 km2) and spectral ($\lambda/\Delta\lambda \approx 20{,}000$) resolution in a package that is >50% smaller, lighter and more cost-effective. CARBO delivers a 25- to 50-fold increase in spatial coverage compared to OCO-2 with no loss of detection sensitivity. Individual CARBO modules weigh < 20 kg, opening diverse new platform opportunities. We will design CARBO modules covering 4 different spectral ranges then build and field test a 2-channel CO2/CH4 and SIF system. This will validate CARBO technology and deliver an instrument that can be adapted for airborne deployment and satellite validation (e.g. OCO-2, OCO-3, TropOMI). Our implementation develops and demonstrates CARBO measurement technologies: (1) Fabricate immersion gratings using e-beam lithography (2) Design and fabricate individual spectrometer/telescope modules in identical housings (3) Integrate two spectrometer/telescope modules into a single system (4) Field-test the integrated system on Mt Wilson, validating alignment, SNR and CO2, CH4 and SIF measurement precision. The CARBO system has entry TRL3. Tasks 1-2 advance CARBO's modular architecture to TRL4. Tasks 3-4 advance the system to exit TRL6. The period of performance is 3 years with a start in CY2017.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Instrument Incubator

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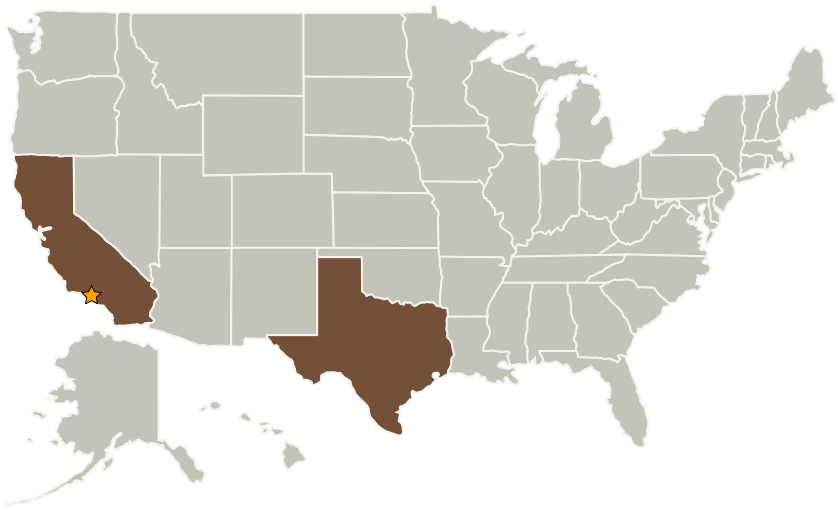
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Texas

Project Management

Program Director:
Pamela S Millar

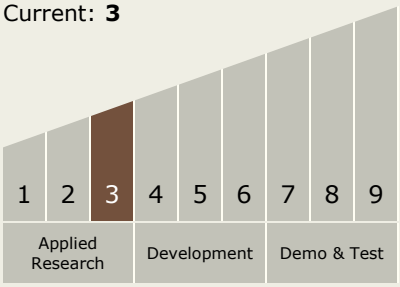
Program Manager:
Parminder S Ghuman

Principal Investigator:
Charles E Miller

Co-Investigators:
Daniel Jaffe
Christian Frankenberg
Gary Spiers
Karen R Piggee
Daniel W Wilson
Stanley P Sander
Annmarie Eldering
Cynthia Brooks

Technology Maturity (TRL)

Start: **3**
Current: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories

Continued on following page.

Technology Areas *(cont.)*

- TX08.2.3 Distributed Aperture

Target Destination

Earth